TECHNOLOGY AND INNOVATION REPORT
2021

UNITED NATIONS
UNCTAD

CATCHING THE WAVES

The great divide, and waves of technological change.

Technological change and inequality through the ages

Real GDP per capita in 2011US$
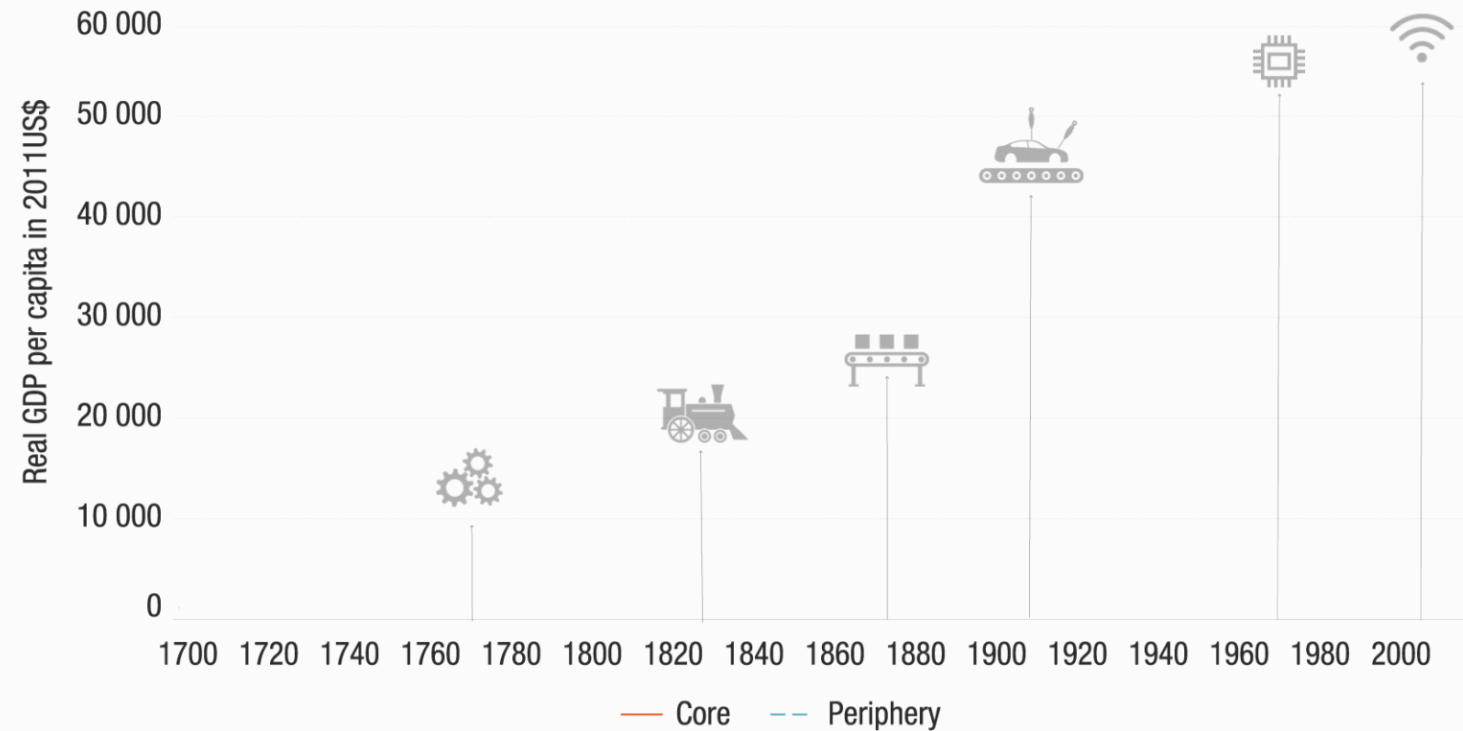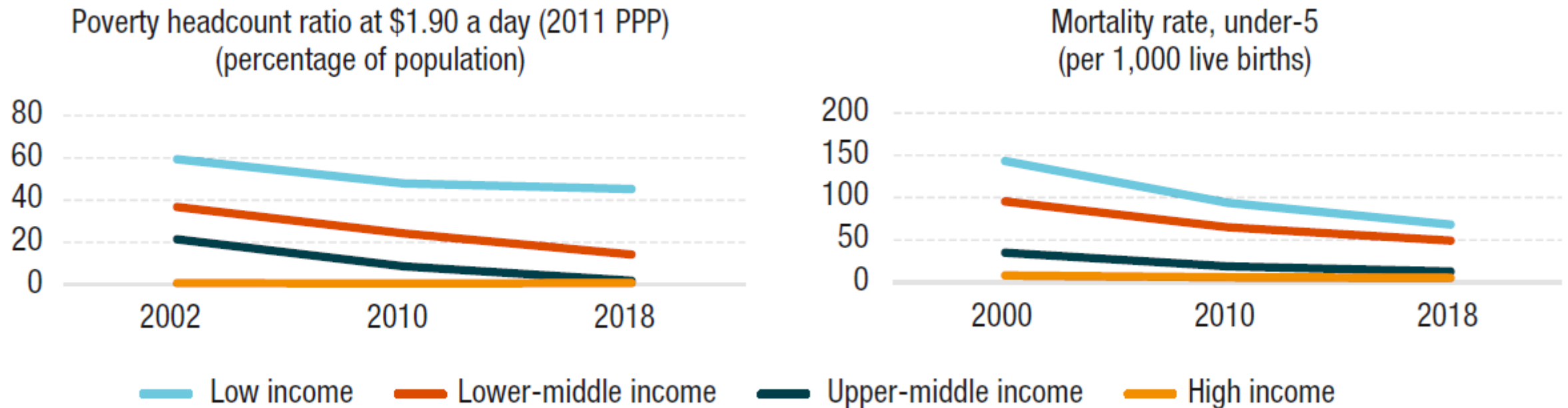
— Core   -- Periphery

Source: UNCTAD's Technology and Innovation Report 2021

PROSPERITY WITH INEQUALITY

Gaps between country groups, selected SDG indicators

Poverty headcount ratio at $1.90 a day (2011 PPP) (percentage of population)

Mortality rate, under-5 (per 1,000 live births)

Low income   Lower-middle income   Upper-middle income   High income

Source: UNCTAD based on data from the World Bank.

WIDE INCOME GAPS

Increasing income inequality, China and India (share of pre-tax national income, percentage)
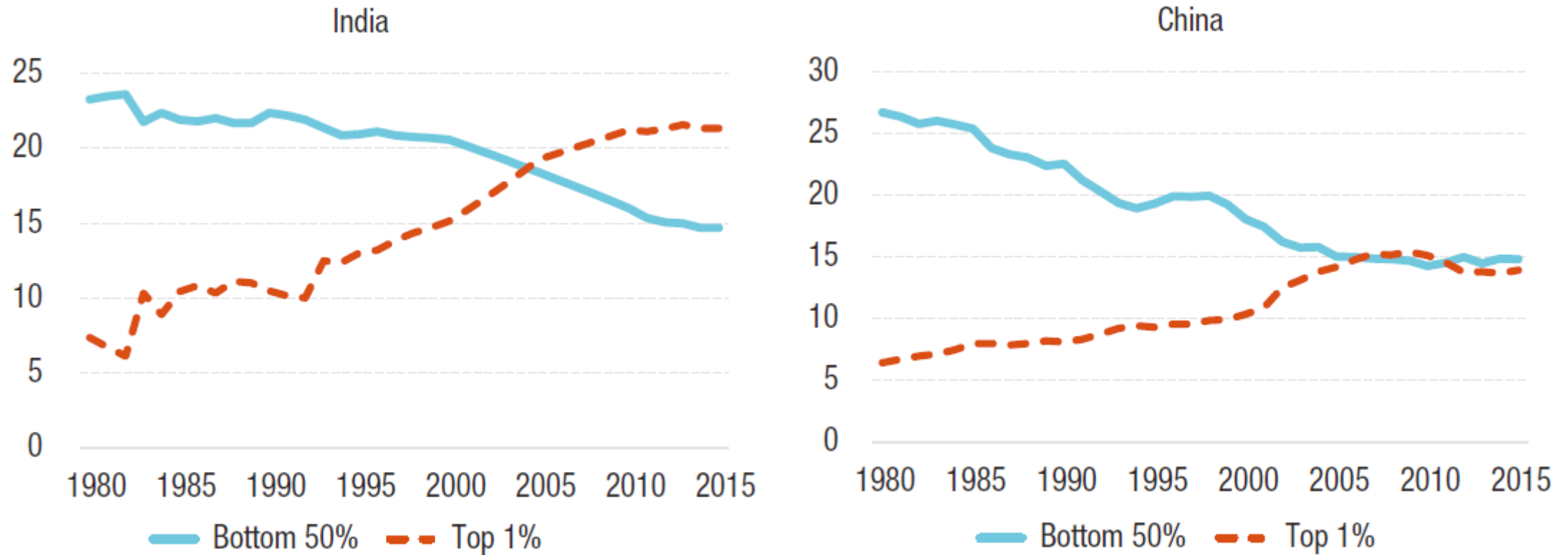
Source: UNCTAD based on data from the World Inequality Lab.

CONTRIBUTION OF INEQUALITY BETWEEN AND WITHIN COUNTRIES TO GLOBAL INEQUALITY

Contribution of inequality between and within countries to global inequality (percentage)
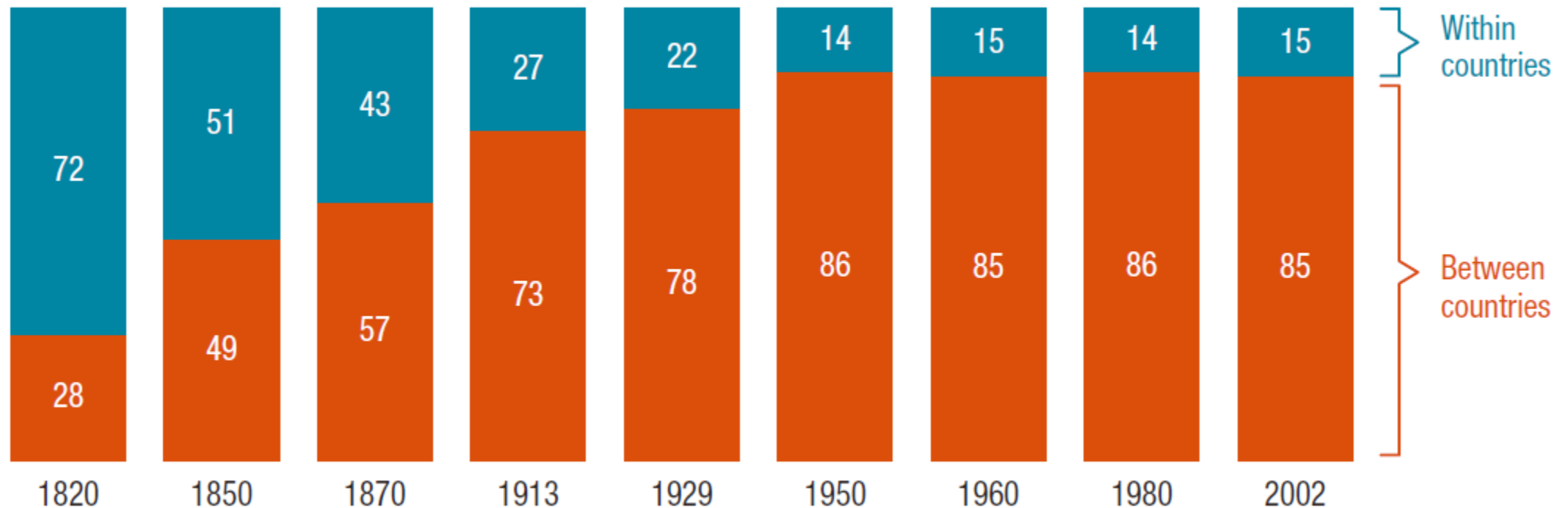
Source: UNCTAD based on Milanovic (2011).

INCREASING INEQUALITY BETWEEN COUNTRIES IN ABSOLUTE TERMS

Rise of average GDP per capita in developing and developed economies

Source: UNCTAD calculations based on UNCTADstat.

TWO-PHASE REVOLUTIONS

Technological revolutions and inequalities

Age of ICT	Industry 4.0

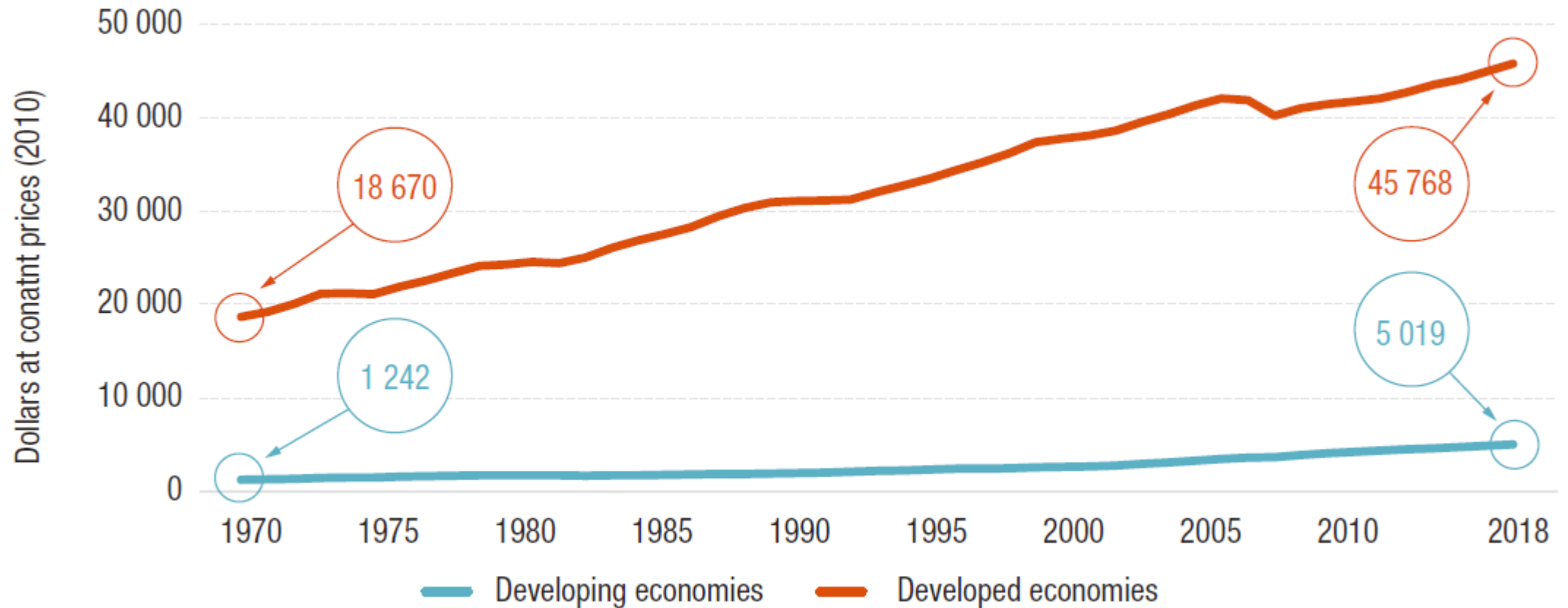Installation period — Deployment period — Installation period — Deployment period

Turning point

Concerns
- concentration of wealth in the ownership of the major digital platforms
- unequal access to the benefits
- broken promise, unequal outcomes and public discontent

Concerns
- income inequality between the workers in the I4.0 and the rest
- "irrational" expectations of profits in new technology
- unemployment
- increasing disparities within and between societies

Degree of technology development

Time

Source: UNCTAD based on Perez (2002).

FRONTIER TECHNOLOGY MARKETS ARE EXPECTED TO GROW RAPIDLY

Market size estimates of Frontier technologies, $billions

2018 — $350 billion

- IoT 130
- Drones 69
- Solar PV 54
- Big data 32
- Robotics 32
- AI 16
- 3D Printing 10
- Gene editing 3.7
- Nanotechnology 1
- Blockchain 0.7
- 5G 0.6

2025 — $3.2 trillion

- IoT 1 500
- Robotics 499
- Solar PV 344
- AI 191
- Big data 157
- Drones 141
- 5G 277
- Blockchain 61
- 3D Printing 44
- Gene editing 9.7
- Nanotechnology 2.2
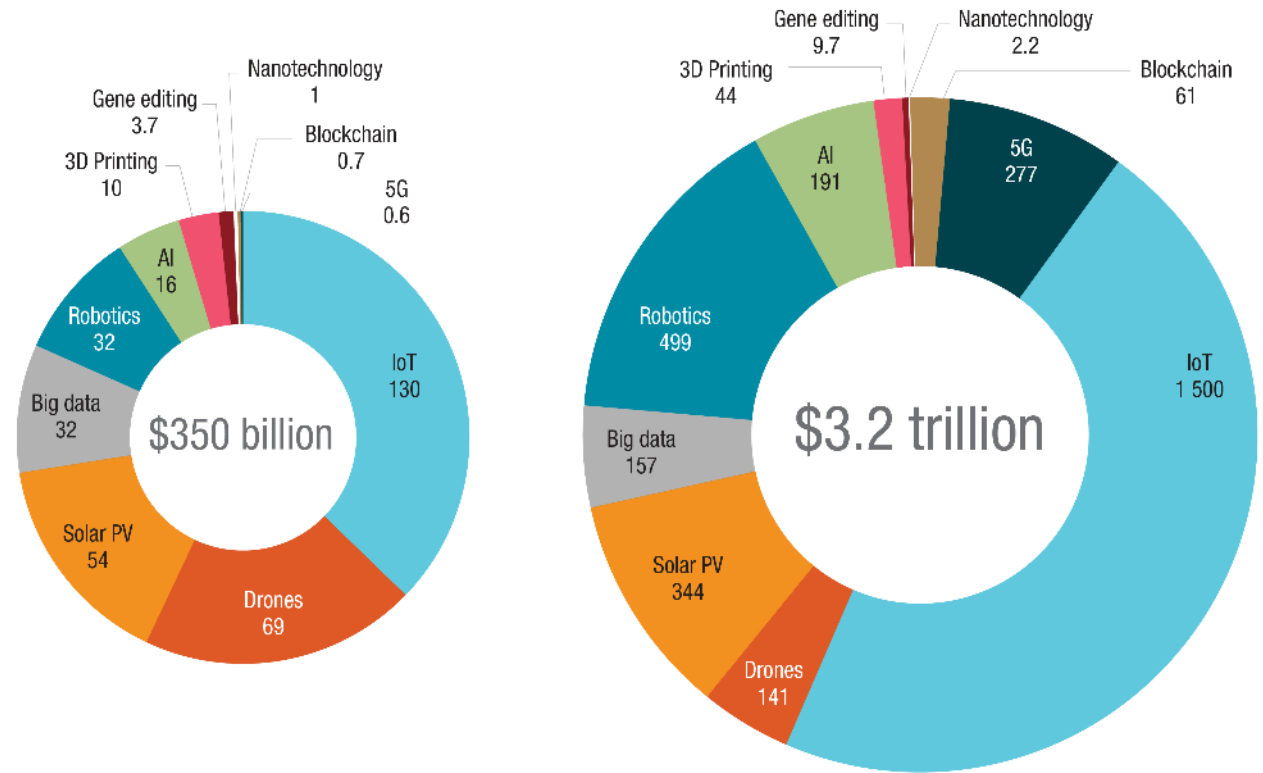
Source: UNCTAD based on data estimates from Froese (2018), MarketsandMarkets (2018), Sawant and Kakadee (2018), Business Wire (2019), Chaudhary et al. (2019), GlobeNewswire (2019b), MarketsandMarkets (2019), MarketWatch (2019a), MarketWatch (20191), Raza (2019), Tewari and Baul (2019), Wagner (2019b), Mordor Intelligence (2020a).

A COUNTRY READINESS INDEX

Structure of the readiness index

Capacity to use, adopt and adapt frontier technologies
(Readiness for frontier technologies index)

ICT deployment	Skills	R&D activity	Industry activity	Access to finance
1) Internet users 2) Mean download speed	1) Expected years of schooling 2) High-skill employment	1) Number of publications 2) Number of patents	1) High-technology manufactures exports 2) Digitally-deliverable services exports	1) Domestic credit to private sector

Source: UNCTAD.

A COUNTRY READINESS INDEX

Readiness towards the use, adoption and adaptation of frontier technologies, selected countries

Country name	Total ranking	ICT ranking	Skills ranking	R&D ranking	Industry ranking	Finance ranking
Top 10						
United States of America	1	14	17	2	20	2
Switzerland	2	7	13	13	3	3
United Kingdom	3	17	12	6	11	14
Sweden	4	1	7	16	15	16
Singapore	5	4	9	18	4	18
Netherlands	6	6	10	15	8	23
Korea, Republic of	7	19	27	3	9	8
Ireland	8	24	6	21	1	87
Germany	9	23	16	5	10	39
Denmark	10	2	4	25	21	5
Selected transition and developing economies						
China	25	99	96	1	7	6
Russian Federation	27	39	28	11	66	45
Brazil	41	73	53	17	42	60
India	43	93	108	4	28	76
South Africa	54	69	84	39	71	13

Source: UNCTAD (see the complete table in Statistical Appendix. Readiness for frontier technologies index).

# COUNTRIES OVERPERFORMING RELATIVE TO PER CAPITA GDP

Gain in ranking position.

	Country	Overperformance (positions)		Country	Overperformance (positions)
1	India	65	11	Morocco	29
2	Philippines	57	12	Kenya	28
3	Ukraine	47	13	Nepal	28
4	Viet Nam	45	14	Serbia	25
5	China	40	15	Korea, Republic of	24
6	Jordan	34	16	Russian Federation	24
7	Brazil	33	17	Lebanon	24
8	Republic of Moldova	33	18	Togo	23
9	South Africa	29	19	United Kingdom	21
10	Tunisia	29	20	Ghana	20

Source: UNCTAD calculations based on GDP data by the World Bank (World Bank, 2020).
Note: Overperformance by gain in ranking position are measured taking the difference in positions between the actual index rankings and the estimated index rankings based on per capita income. For instance, India's actual index ranking was 43 while the estimated index ranking based on per capita income was 108. Hence, India overperformed by 65 ranking positions.
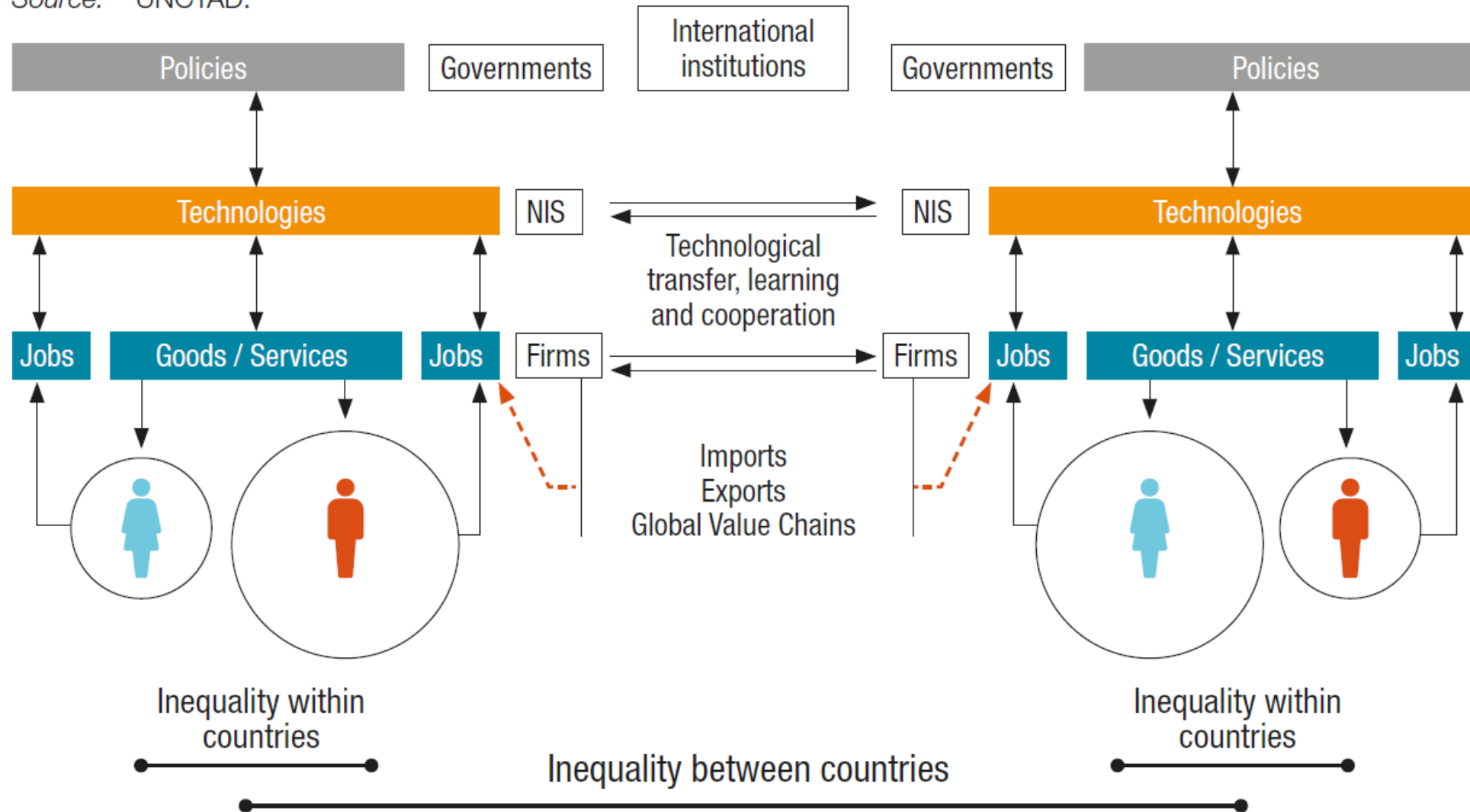
CONCEPTUAL FRAMEWORK

Conceptual framework: Technologies affect inequalities through jobs, and goods and services.
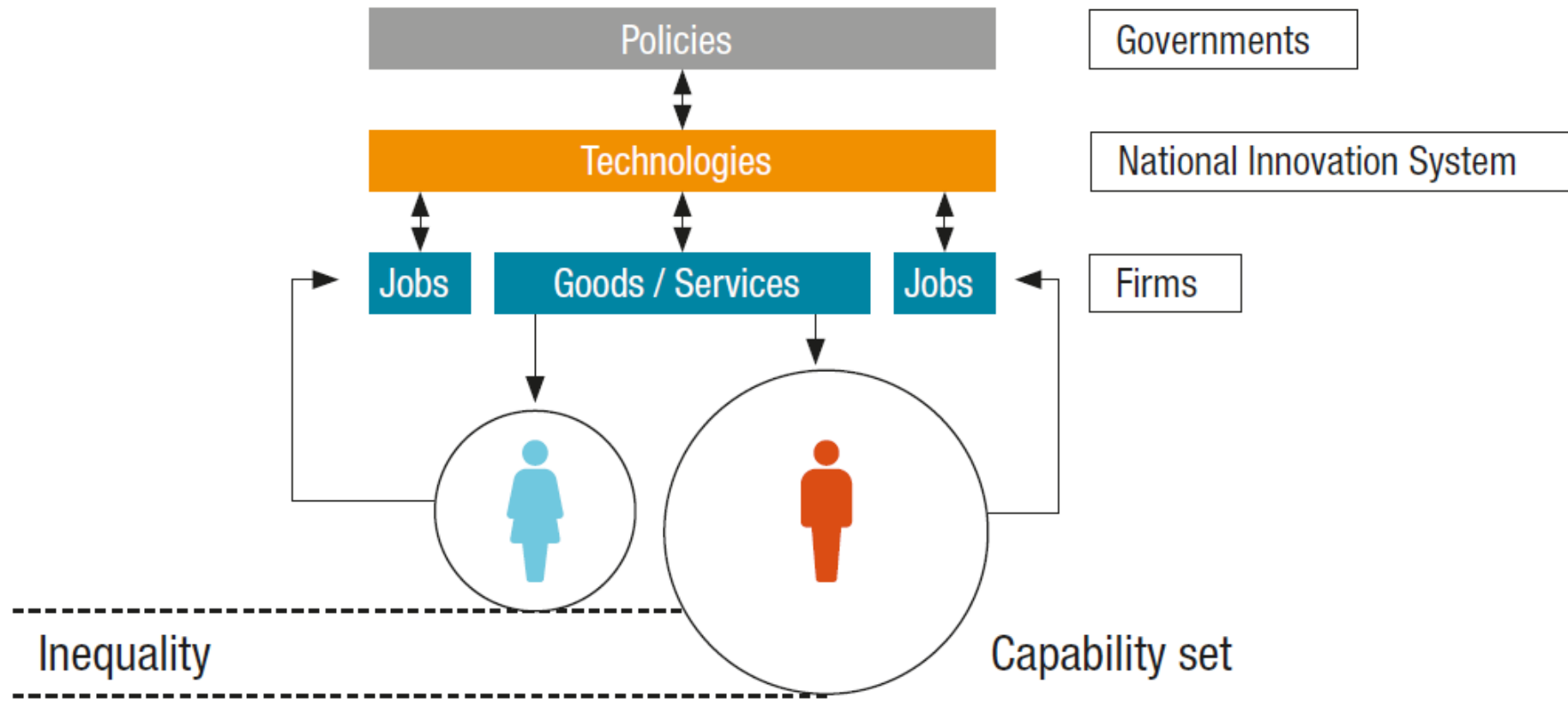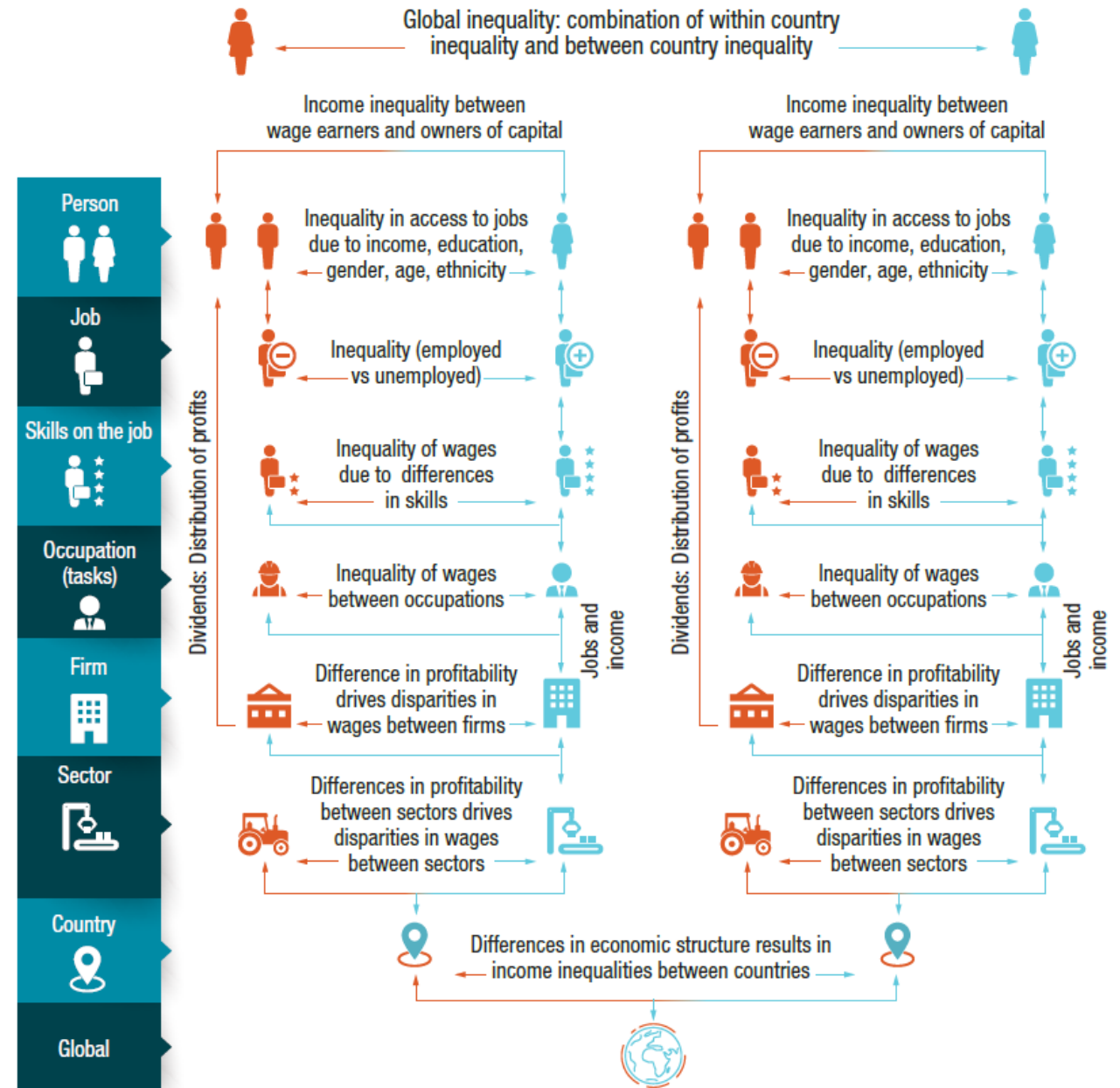

Source: UNCTAD.

CONCEPTUAL FRAMEWORK

Source: UNCTAD.
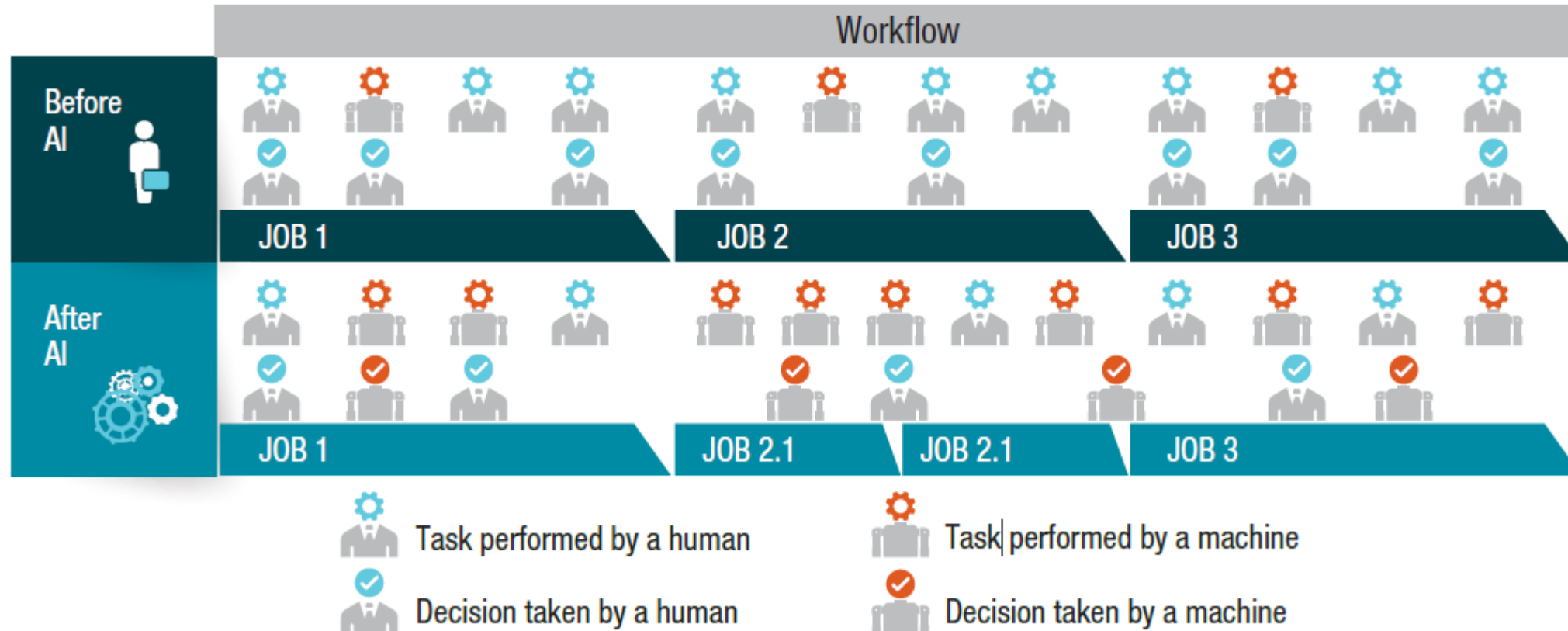
HUMANS & MACHINES AT WORK

A chain reaction of inequalities

Global inequality: combination of within country inequality and between country inequality

Person

Job

Skills on the job

Occupation (tasks)

Firm

Sector

Country

Global

Income inequality between wage earners and owners of capital

Inequality in access to jobs due to income, education, gender, age, ethnicity

Inequality (employed vs unemployed)

Inequality of wages due to differences in skills

Inequality of wages between occupations

Difference in profitability drives disparities in wages between firms

Differences in profitability between sectors drives disparities in wages between sectors

Differences in economic structure results in income inequalities between countries

Dividends: Distribution of profits

Jobs and income

Source: UNCTAD.

AUTOMATION TAKING JOBS

Jobs, tasks, decisions and automation by AI

Workflow

Before AI

JOB 1   JOB 2   JOB 3

After AI

JOB 1   JOB 2.1   JOB 2.1   JOB 3

Task performed by a human   Task performed by a machine

Decision taken by a human   Decision taken by a machine

Source: UNCTAD based on Agrawal et al. (2018) and Acemoglu and Restrepo (2019).

AI AND GLOBAL ECONOMIC INEQUALITIES

TYPE OF INPUT DATA

1 If AI primarily uses 'big data' generated by users, this will mainly benefit the United States and China, whose digital platforms gather massive amounts of such data.

2 If it primarily uses big data gathered by the Internet of Things this would benefit other countries with strong manufacturing – such as the EU, Japan and the Republic of Korea.
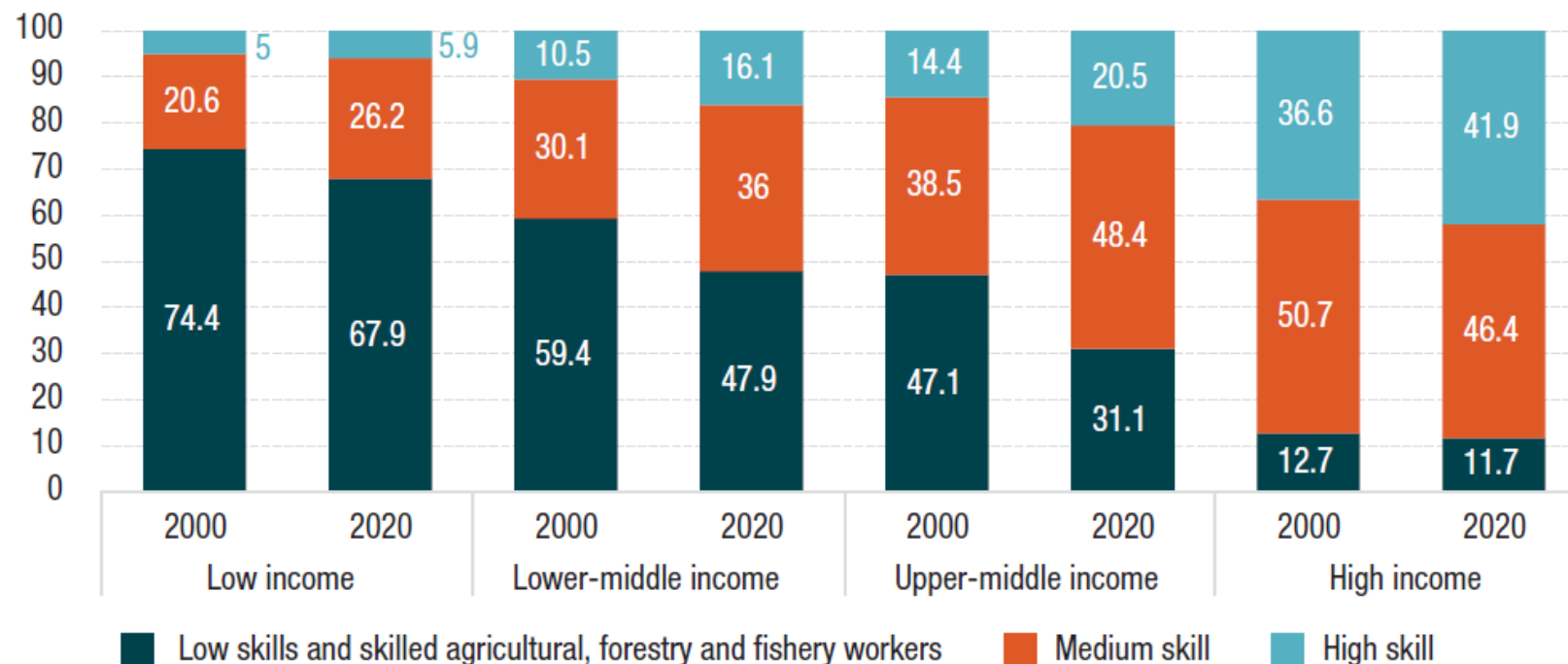
3 Allow computers to learn more like humans by equipping them with conceptual frameworks of how the world works, this would still demand resources and capabilities more likely to be found in the developed countries.

JOB POLARIZATION

Employment by skill level
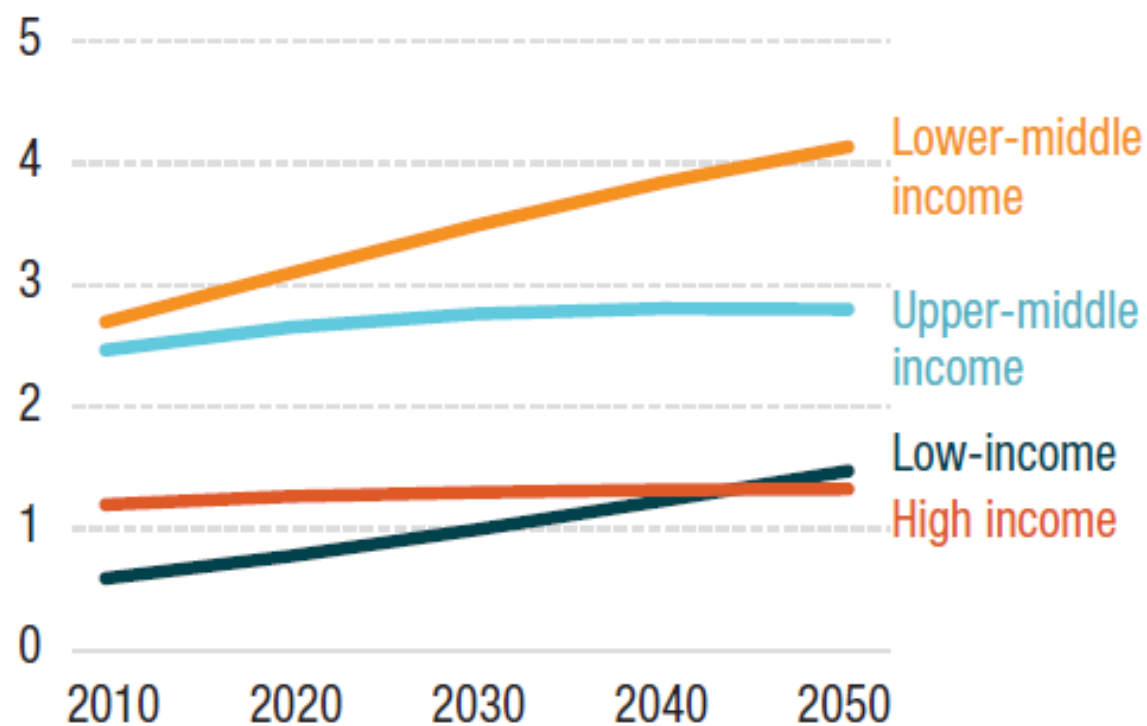(Percentage of total civil employment)

	2000	2020	2000	2020	2000	2020	2000	2020
High skill	5	5.9	10.5	16.1	14.4	20.5	36.6	41.9
Medium skill	20.6	26.2	30.1	36	38.5	48.4	50.7	46.4
Low skills	74.4	67.9	59.4	47.9	47.1	31.1	12.7	11.7
	Low income		Lower-middle income		Upper-middle income		High income	

■ Low skills and skilled agricultural, forestry and fishery workers   ■ Medium skill   ■ High skill

Source: UNCTAD based on data from ILOStat according to the ISCO-08.

Notes: Following ISCO-08 construction logic, a high skill level refers to major groups 1 to 3, a medium skill level to major groups 4, 5, 7 and 8, and a low skill level to major group 9 (skilled agricultural, forestry and fishery workers correspond to group 6, which is also considered medium skill but is combined with group 9 in the data made available by ILOStat).[54]
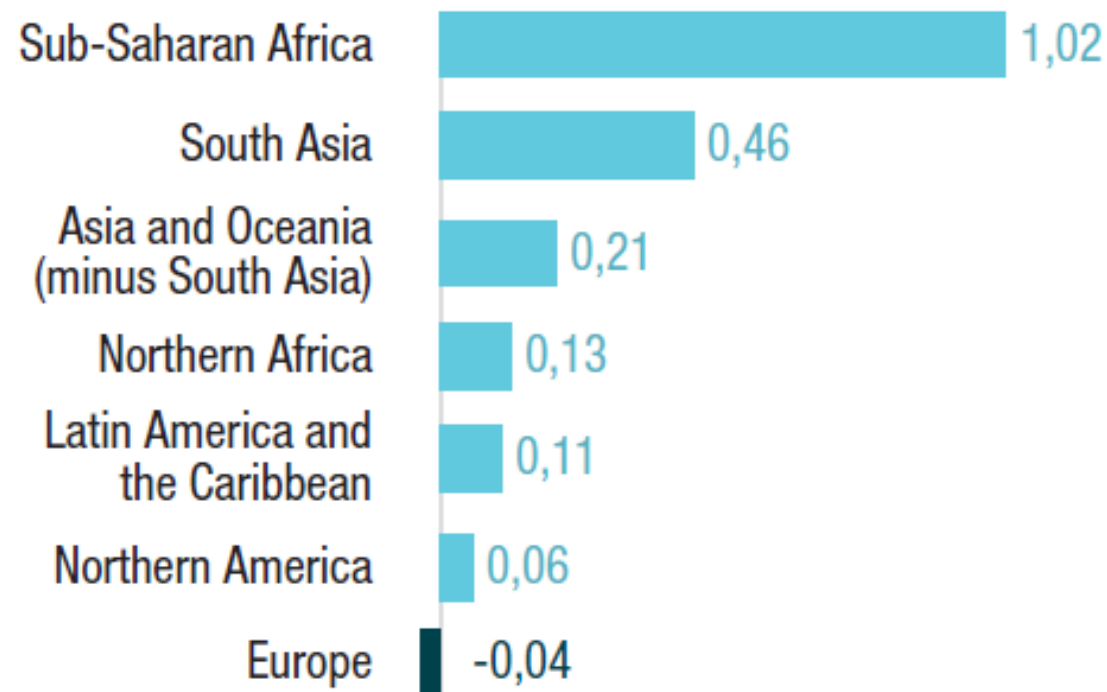
DEMOGRAPHIC CHANGES
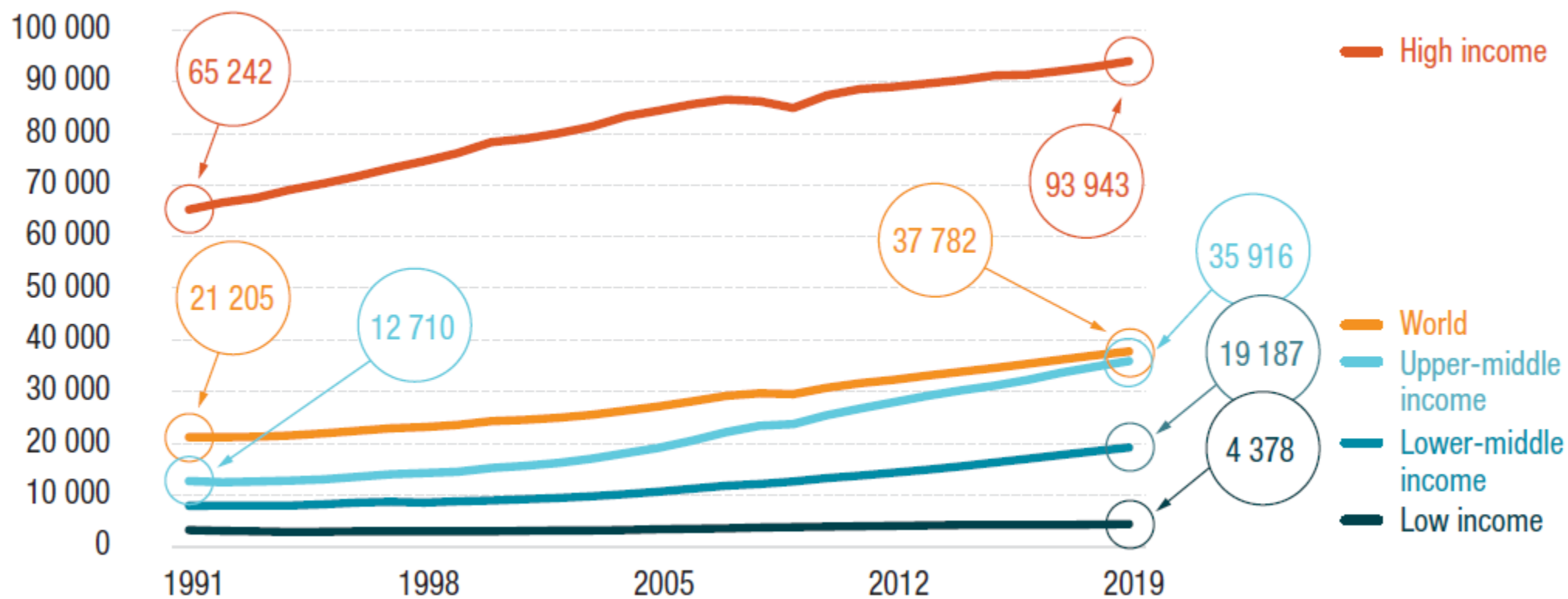
Population, by country income group, billions

- Lower-middle income
- Upper-middle income
- Low-income
- High income

2010   2020   2030   2040   2050

Source: UNCTADStat.

Change in population between 2020 and 2050, billions

Sub-Saharan Africa	1,02
South Asia	0,46
Asia and Oceania (minus South Asia)	0,21
Northern Africa	0,13
Latin America and the Caribbean	0,11
Northern America	0,06
Europe	-0,04

Source: UNCTADStat.

TECHNOLOGICAL GAP

Output per worker, income groupings, $constant international 2011 prices

65 242
93 943
37 782
35 916
21 205
12 710
19 187
4 378

High income
World
Upper-middle income
Lower-middle income
Low income

1991 1998 2005 2012 2019

Source: UNCTAD based on data from ILOStat.

SLOW DIVERSIFICATION

Association between total GDP and diversification and complexity of economies, 2019

$$y = 267.34\ x^{0.4652}$$
$$R^2 = 0.7501$$

Source: UNCTAD *based on UN COMTRADE data.*
Note: Based on the number of product categories exported, at the SITC 5-digit level, further disaggregated by unit value using the methodology presented in Freire (2017).

Products connected to each other based on the likelihood of being exported together, selected clusters of products identified

Source: UNCTAD based on The Atlas of Economic Complexity (2020).
Note: Each dot represents a product using the HS 4-digit data classification. Products that are connected have a higher probability of being exported together. Selected clusters of products are indicated for illustrative purposes.

WEAK FINANCING MECHANISMS

R&D expenditures by subgroups

	R&D expenditures (average annual growth rate, 2007-2017, percentage)	GDP (average annual growth rate, 2007-2017, percentage)	R&D expenditures as a percentage of GDP, 2017
Landlocked Developing Countries	5.0	5.8	0.21
Small Island Developing States	2.5	0.9	0.96
Sub-Saharan Africa	4.4	4.4	0.38
Least Developed Countries	6.2	5.1	0.20
Low income countries	7.2	4.0	0.29
Lower middle-income countries	4.5	5.5	0.43
Upper middle-income countries	10.2	5.0	1.48
High income countries	2.3	1.4	2.42
World	4.3	2.6	1.72

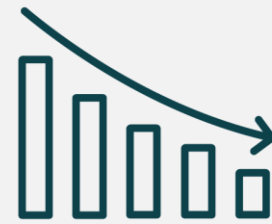Source: UNCTAD based on UNCTAD (2020), UNESCO (2020).

CHALLENGES FOR DEVELOPING COUNTRIES

Demographic changes

Existing technological gaps

Low economic diversification
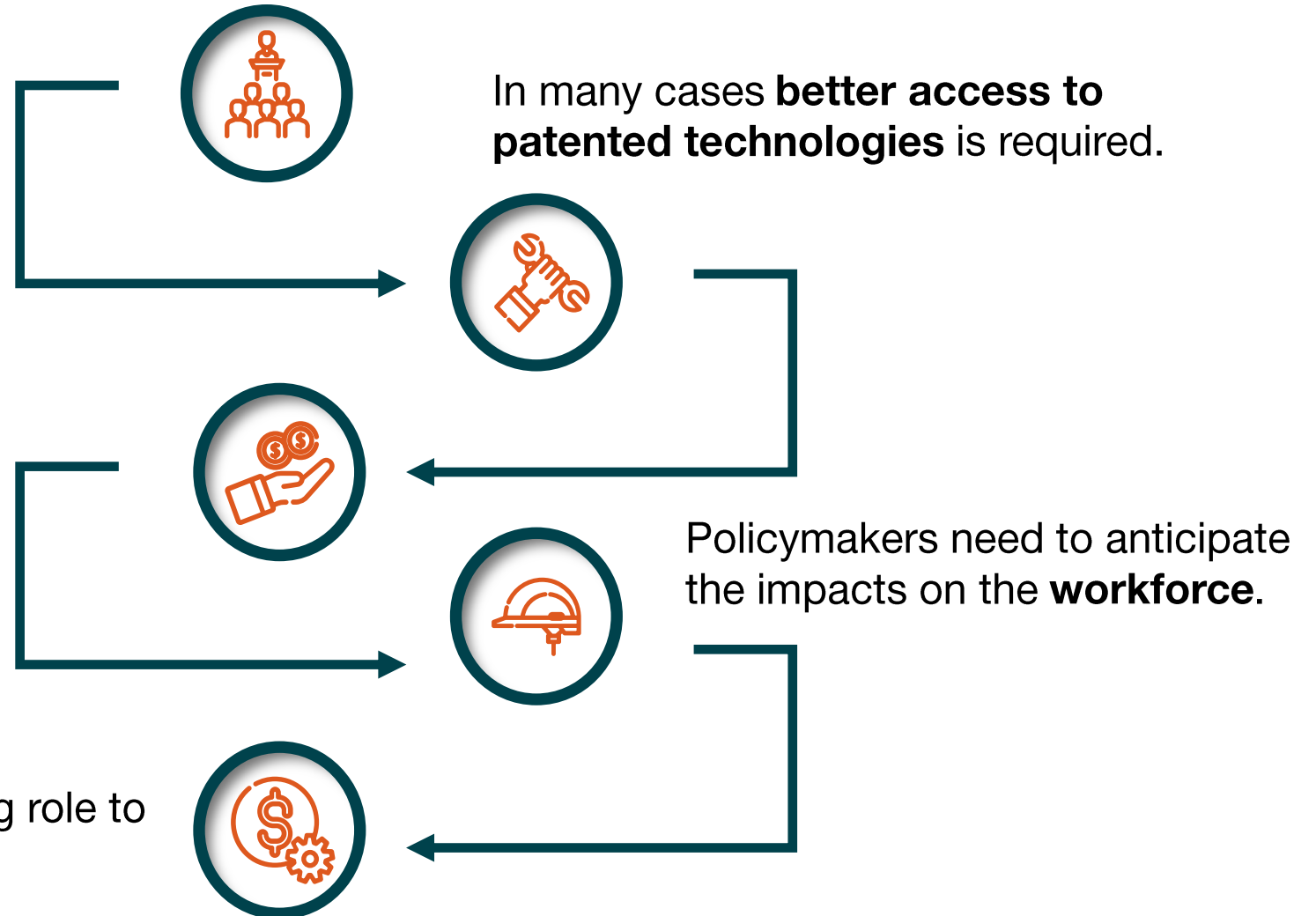
Weak financing mechanism

Stringent intellectual property rights

ACCELERATING TOWARDS **INDUSTRY 4.0**

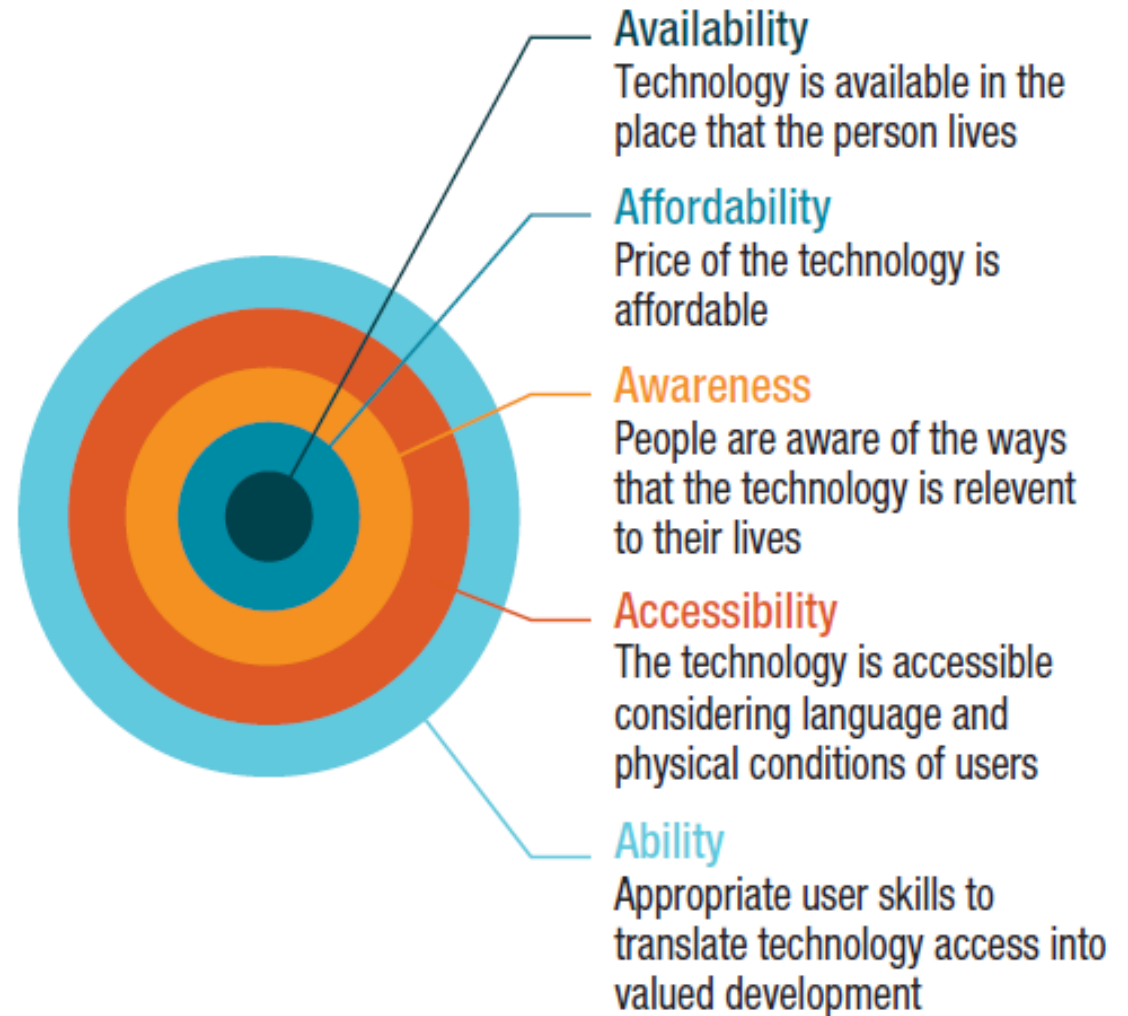**National innovation policies** need to align with industrial policies.

In many cases **better access to patented technologies** is required.

Finance source include official sources, impact investment, venture capital, crowdfunding, and Innovation and technology funds.

Policymakers need to anticipate the impacts on the **workforce**.

Labour unions will also have a big role to play to protect workers

TECHNOLOGIES AFFECTING INEQUALITIES THROUGH ACCESS & DESIGN

Five as of technology access

Availability
Technology is available in the place that the person lives

Affordability
Price of the technology is affordable

Awareness
People are aware of the ways that the technology is relevent to their lives

Accessibility
The technology is accessible considering language and physical conditions of users

Ability
Appropriate user skills to translate technology access into valued development

Source: UNCTAD based on Roberts (2017) and Hernandez and Roberts (2018).

CHALLENGES FOR DEVELOPING COUNTRIES

Higher levels of poverty

Average share of the population living in extreme poverty: upper-middle-income 2% low-income countries 45%.

Digital divide

Almost half of the world's population remains offline

Shortage of Skills

in developing countries, the basic computer skills are on average 20 percentage points lower than in developed countries

RISKS OF **BIAS AND DISCRIMINATION**

AI algorithms
with built in bias

Genomic
inequalities

Gene editing and
intellectual property

Ethical questions
in gene editing

DIRECTED TO SUSTAINABLE DEVELOPMENT

International community needs to **guide new and emerging technologies**

Outcomes should be **fair, transparent, accountable, and inclusive**

It's important to **establish ethical frameworks, particularly for the deployment of AI**

For human germline gene editing there needs to be a broad **consensus on ethical and societal issues**

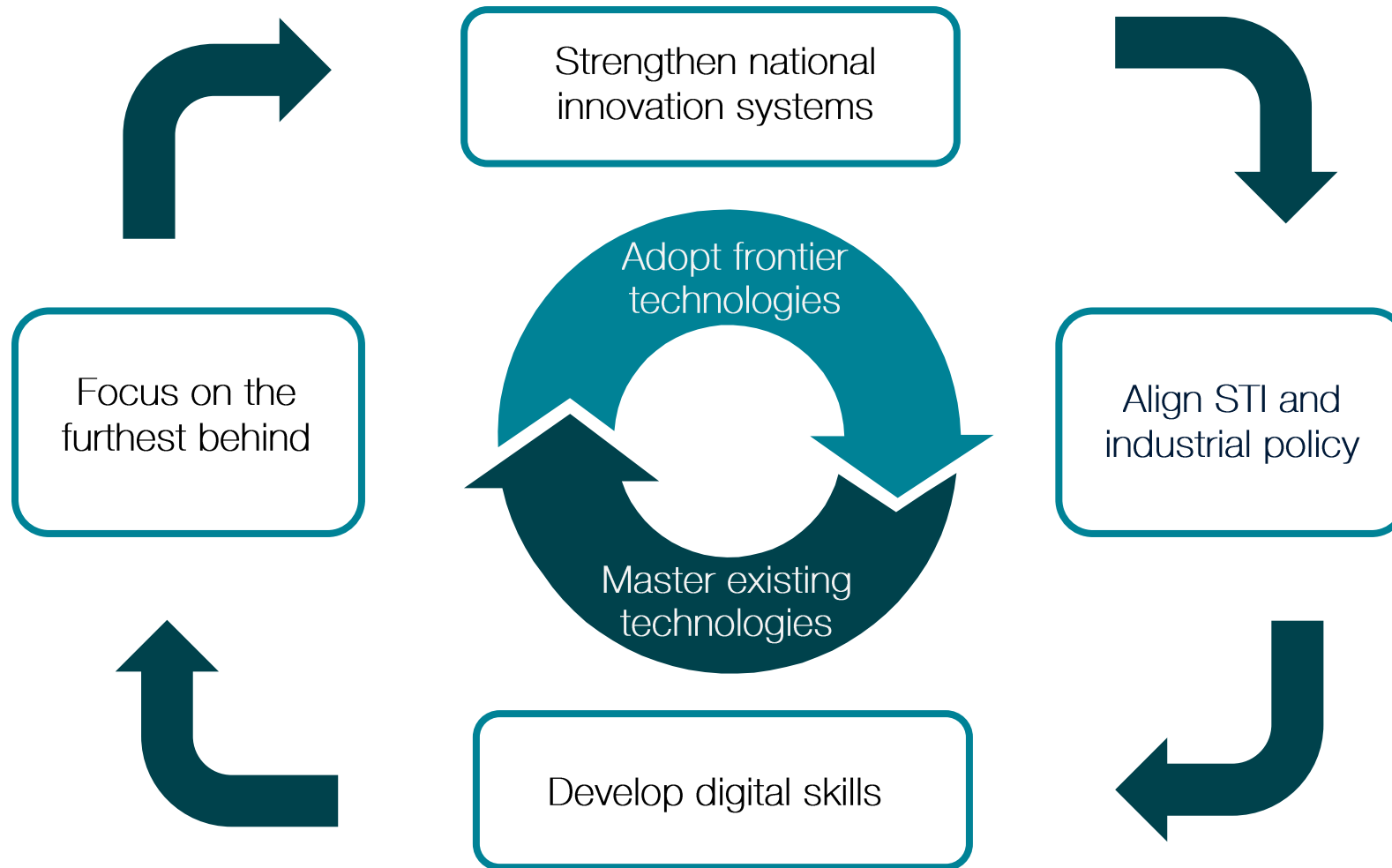# GUIDING INNOVATION TOWARDS REDUCING INEQUALITIES
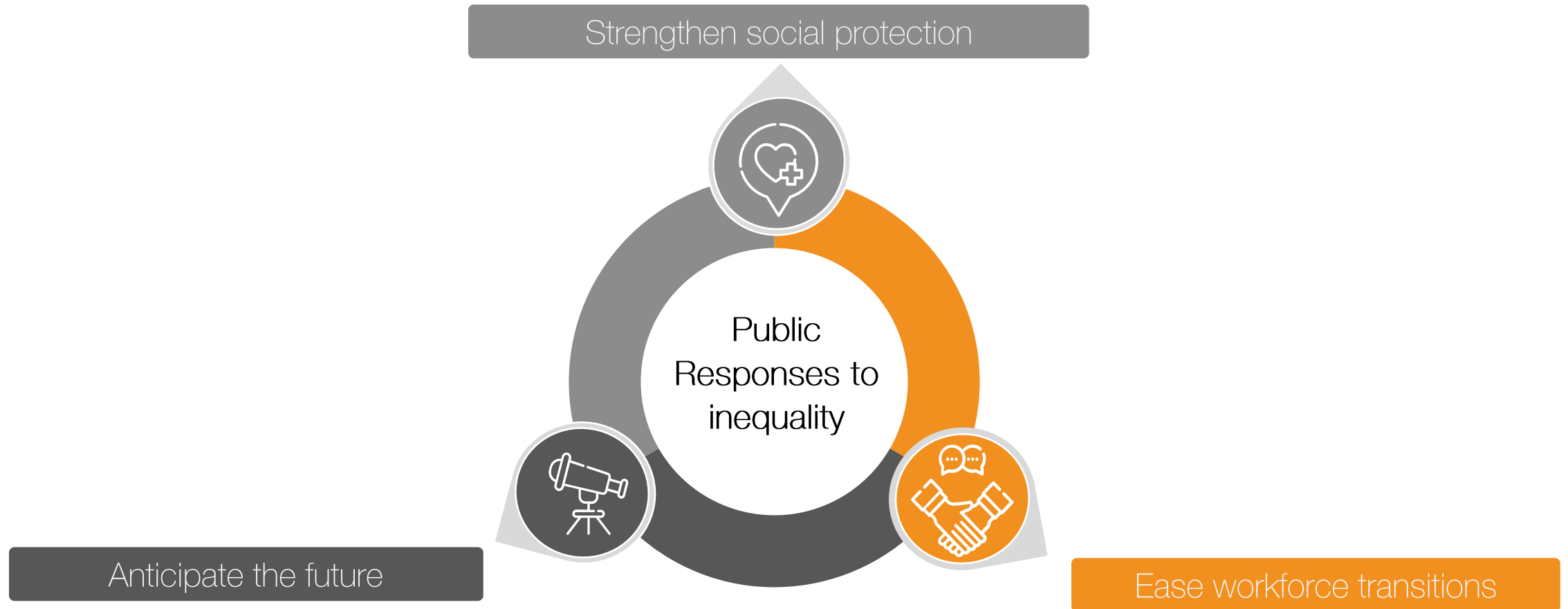

Extend frontier technologies to the poor

Set strategic directions using the SDGs

Support inclusive innovation systems

Use frontier technologies in the public sector

TWIN TECHNOLOGY TARGETS

Strengthen national innovation systems

Adopt frontier technologies

Master existing technologies

Focus on the furthest behind

Align STI and industrial policy

Develop digital skills

MITIGATING RISKS

Strengthen social protection

Public Responses to inequality

Anticipate the future

Ease workforce transitions

PRIORITIES FOR INTERNATIONAL COOPERATION

Build stronger national capacities in STI

Smooth technology transfer

Increase women participation in STEM

Improve foresight and technological assessment

Promote inclusive debate on frontier technologies